Inelastic Analysis Capability

APPLIED MECHANICS

Applied Engineering Solutions

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Providing advanced inelastic analysis and testing capabilities that result in effective design solutions.

Overview

Structural design acceptance criteria are typically stress-based. These stress-based criteria are usually prudent for normal or sustained loading conditions where static loading of pressure, weight or thermal effects dominate. These criteria help achieve desired safety margins. However, many designs of structural components under dynamic load conditions become excessively conservative trying to satisfy these same stress-based design criteria. This is especially true in permanent deformation situations that occur as a result of low probability, off-normal events – such as accidental drops, collisions or other impacts. The standard design solution is to use thicker material. Yet, increasing thickness can significantly degrade a component's structural performance over its design life – especially if thermal gradient loads are significant. And, the expense of redesigning and increasing the amount of material raises the life cycle cost of the component.

Using computational models, engineers can perform inelastic analyses to predict and improve the performance of proposed designs.

INEEL Solutions

Inelastic or plastic analysis capabilities have greatly expanded and improved over the past twenty years. Plastic analyses can now accurately determine the structural response of components subjected to loads producing permanent deformations. However, the accuracy of the plastic analyses is very dependent on the proper modeling of the component and the proper input of material data that accounts for strain-rate effects.

The INEEL has expertise in not only performing plastic analyses, but in validating those analysis predictions with actual tests. Reduced and full-scale test specimens, ranging from 100 to 10,000 pounds in weight, have been drop tested. Comparisons between the dropped test specimens and plastic analyses have indicated an ability to match

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deformations to within 5 percent accuracy, even with strain levels in excess of 50 percent.

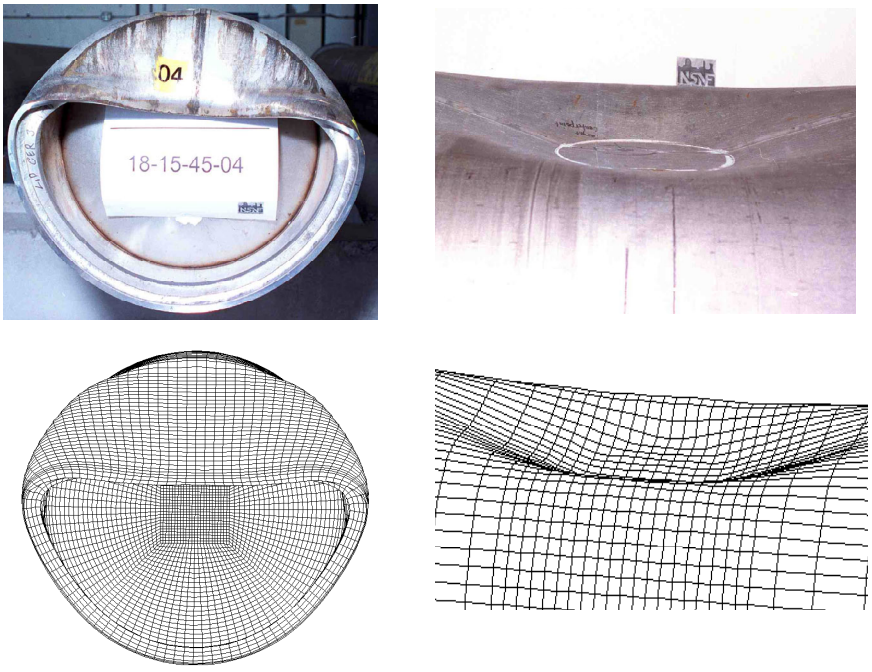
This expertise led to the development of the Department of Energy's standardized spent nuclear fuel canister. This canister has an efficient, yet robust design that allows it to be used for interim storage, transportation and disposal in a repository.

Benefits

The Energy and Engineering Technology Directorate at the INEEL has the proven capability to perform detailed plastic analyses with confidence in results due to significant amounts of validation testing. With this capability, field engineering designs that reflect optimized efficiencies can be quickly achieved.

Applied Mechanics Capabilities

- Analysis group members average more than 25 years of structural experience
- Have performed plastic analysis tasks on a full-time basis for last seven years
- Plastic analysis methodologies employed are proven and validated by actual tests
- Applications of ABAQUS/Explicit software are verified and validated.



Comparing photos of actual test results to modeling images reveal that predictive computational models are accurate to within 5 percent of the test data.